

# BOTANICAL GAZETTE

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JULIUS VON SACHS.

A BIOGRAPHICAL SKETCH: WITH PORTRAIT.

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[In the preparation of this sketch for the BOTANICAL GAZETTE, Dr. Noll concluded that the very full one which he had prepared for *Naturwissenschaftliche Rundschau*, and which appeared in the issues of September 4 and 11 (1897) of that journal, had better be translated and abridged. This has been done by John G. Coulter.—EDS.]

ON May 29, 1897, death released from a long struggle with a hopeless illness a man who, in the fullness of his power, had left a permanent impress upon research in vegetable physiology. In the history of physiology his name will be inseparably connected with an epoch of great advance, of exact investigation, and of extension of physiological study into all structure.

Julius Sachs, the third son of Graveur Sachs, was born at Breslau, October 2, 1832.<sup>1</sup> The quiet family life was largely spent in the country, and the awakening mind of Sachs was early directed toward the observation of nature. With passionate zeal he collected all obtainable plant forms, pressed,

<sup>1</sup>In my statements regarding the family, I am dependent upon the material which the younger daughter of Dr. Sachs, Fraulein Marie Sachs, has kindly placed at my disposal. I am especially indebted also to Professor F. Cohn, Professor Goebel, Professor Körnicke, Professor Nobbe, Professor Strasburger, and Ministerial-Director Dr. H. Thiel, for their invaluable assistance.

identified, and even cultivated them, without, however, losing all the lively interest of a boy in other amusements.

Near the town house of the Sachs at Breslau there stood in a large garden a small one-storied structure, insignificant from without, and much restricted within. From this unpretentious building, however, there was exerted upon the scientific world without a mighty influence, and from this place there went out young men inspired by the zeal of an exact, experimental investigator, and pledged to enrich the store of biological knowledge. That little house was the laboratory of the famous physiologist Purkinje. It was, perhaps, the first place where exact physiological experiments were successfully performed. In this garden young Sachs was the playmate of the two sons of Purkinje. They were three keen and enthusiastic observers with a common and absorbing interest in nature. Purkinje, who, in addition to his studies in animal physiology, occupied himself to some extent with botanical investigations, very soon recognized the gifts of young Sachs, and aroused in him an active interest in the work of the laboratory. At this time, besides Sachs, there were others at work in the Purkinje laboratory who later became noteworthy botanists. Among these were Ferd. Cohn and N. Pringsheim.

At about this time heavy misfortune fell to the lot of the Sachs family. In 1848 an apoplectic stroke killed the father, and scarcely a year later cholera took from the seventeen-year-old boy his mother and a brother. Not yet out of the gymnasium, young Sachs was thrown wholly upon his own resources. With new determination he continued his work at sketches, lithographs, and painting, and sought thereby to sustain himself at his studies. That was no easy task, however, and already the young man, with his characteristic determination, had decided to become a sailor, when Purkinje, who had meanwhile accepted a call to Prague, afforded him an opportunity to come there. Sachs was received as a son into the Purkinje house at Prague. He was enabled to complete his interrupted course at the Gymnasium, and meanwhile assisted Purkinje, and had much to do

with the making of illustrative wall charts, and with microscopical work. Purkinje, a keen investigator, with a talent for geniality and cordiality, responsive in his contact with young people, must have been in his domestic life a strong master, who was a little particular and exacting in his methods of training. Sachs, who in his young years was certainly accustomed to work and privation, has repeatedly made mention of the "harte Arbeit" with which he had to make recompense for the privilege of his sojourn at the Purkinje establishment. In order to satisfy all the demands which were made upon him, it became necessary for him to reinforce his often exhausted nerves with artificial stimulants, whose use, learned here, finally became fatal to the never resting man.

Having successfully passed the entrance examinations, Sachs was admitted as a student at the University of Prague in 1851. For a short time he attended the lectures of the botanist, Kos-telezky, and later those of Willkomm. He occupied himself somewhat with physics and mathematics, but was especially interested in philosophy under the direction of Professor Zimmermann, who won a great influence over the student, and deemed him worthy of a friendship almost paternal. The work which he carried on at the same time in the Purkinje laboratory was limited exclusively to animal physiology.

In Prague, through the influence of Purkinje, Sachs learned Bohemian, and was induced to publish a number of scientific contributions in the Bohemian journal *Ziva*, which he signed with a Bohemian name.<sup>2</sup>

In 1855 his name appeared in the *Botanische Zeitung* for the first time in any German scientific journal. The very first contribution of the young investigator, dated 1853, gives evidence of his keen insight. It is his account of *Collema bulbosum* (*pulposa*), in which he discussed the change which he had observed in nostoc colonies growing in Collema, and urged that this "Unwandlung" was caused by the appearance of "gleichsam

<sup>2</sup>A German list of the titles of these publications occurs in the catalogue which is published with Goebel's "Nachruf," *Flora*, supplementary volume of 1897, p. 126.

parasitischer Pilzfäden" in union with the nostoc. Sachs himself doubtless did not recognize at this time the "Sachverständigen," whose first prophecy he here expressed, and which, later, an exhaustive study was to bring finally to general acceptance. This first presentation, however, is of much historical interest, inasmuch as it describes for the first time the organic interdependence of lichen fungi and algæ. Probably it was the fault of circumstances that this presentation of Sachs was omitted from the "Register," and that this important contribution has been so generally overlooked. Even in the work of Reess, in which sixteen years later the synthesis between the nostoc of Collema and the Collema-hyphæ is noted, no mention is made of the precisely similar observations of Sachs.

In 1856 Sachs received his degree, and a year later separated himself from Purkinje and began to devote himself to the study of plant physiology. To obtain means for living, however, he continued to devote some attention to drawing and to writing. Problems pertaining to seed germination, and the earliest development of plant organs, attracted his attention before all else, and chief among the work undertaken in this first period at Prague was the inauguration of studies upon germination, which even now are having their continuation in the latest observations upon metabolism and "Stoff-wanderung."

In April of 1859, through the solicitation of the zoologist Stein, and upon the recommendation of Hofmeister, Sachs was called to Tharand as an assistant to Professor A. Stöckhardt. When Stöckhardt learned from the friends of Sachs of the water-culture experiments which the latter had begun at Prague, he recommended that the scope of the experiment station at Tharand be extended so that experimental plant physiology might be introduced upon no mean scale, and that the "especially well qualified Dr. Julius Sachs, of Prague" be called to take charge of the new department. And so at Tharand, jointly with Stöckhardt, Sachs carried out that pioneer work of his upon the nourishment of plants studied by means of water-

cultures. A whole series of contributions, appearing for the most part in the *Landw. Versuchs-Stat.*, bear eloquent testimony to his ceaseless activity during the comparatively short sojourn at Tharand.

Early in 1861 Sachs was elected head of the newly created experiment station for plant physiology and docent in plant and animal physiology at Chemnitz, but before he entered definitely upon his duties there, he accepted a call, received in April of the same year, to a professorship in the agricultural academy at Poppelsdorf. Here, at first, he had charge of both plant and animal physiology and mineralogy.

At Poppelsdorf Sachs married an Austrian lady, a talented woman, whose limited income enabled the maintenance of a very modest establishment. At this time Sachs' salary was but 700 thalers.

The laboratories of the investigator were at this time as modest and limited as his domestic establishment. Two very small rooms, and an apartment in the basement, which also served the housemaster for a kitchen, formed the "institute" in which Sachs and his students worked. With them were associated G. Kraus, now professor at Halle, and the honored Dr. Thiel,<sup>3</sup> who is still Ministerial-director of the scientific study of agriculture.

The six years of Sachs' activity at Poppelsdorf were extraordinarily rich in scientific results. Fifteen important contributions upon the germination process, upon metabolism and the translocation of food material, upon the influence of light and temperature changes upon particular phases of vegetation, appeared in the years 1862-1864 alone. His work at this time upon the metamorphosis of food material during the germination and early growth of plants demonstrated the easy control of the method of transforming glucose into starch and the reverse, the transformation from carbohydrates into fats, albu-

<sup>3</sup> In simple but telling words, full of sincere feeling, this old and true friend of Sachs, at the semi-centennial jubilee of the Academy, told of all those old homely conditions which surrounded the epoch making work of the dead investigator.

minous bodies, etc., and the method of their translocation in the plant body. Although his experiments upon these problems were conducted with the assistance only of the very crude methods of microscopical technique then in vogue, despite our vastly improved methods we are scarcely able to repeat them. But, according to Sachs' own words, the most important outcome of this work was the idea which it prompted, that he must seek the true organs of assimilation in the chlorophyll bodies, a theory which Sachs stated first hypothetically, yet precisely, and which later was established by him through exhaustive research.

Besides these numerous and important contributions there appeared also during the time of his activity as a teacher and investigator at Poppelsdorf the *Handbook of experimental plant physiology*, being part of a general treatise which, at Sachs' suggestion, came out in four volumes, edited by Hofmeister in conjunction with De Bary, Irmisch, Pringsheim, and Sachs. Although Sachs' particular field of physiology has not been the most worked since, the part which he contributed to the *Handbook* is today the best known and most read. On account of its clear method of presentation, and its wealth of striking observations, it yet serves as a valuable source of information. Few of the many observations and suggestions which Sachs made here, with so free a mind, and with such remarkable insight, have been followed up since either by himself or others. The exact physical and mathematical studies of his undergraduate days, the excellent training he had had from Purkinje in the manipulation of physiological experiments, and his remarkably clear and complete method of exposition, united to give to this, his first work of importance, so rare a value that the young docent, known hitherto only for his undaunted energy and manly beauty, gained at once a place of recognition in the world of learning. In humorous vein he once described for me the wonderful "Umschwung" which the appearance of the *Handbook* had gained him.

When De Bary, in the spring of 1867, resigned his chair at Freiburg, Sachs was called to it, and one year later he succeeded

Schenk at Würzburg. Here, where the administration was in fullest accord with the desires of the great investigator, and where he received fullest recognition, Sachs remained thirty years, always hard at work.

During his professorship at Würzburg, Professor Sachs declined calls to high positions at Jena, Heidelberg, Vienna, Dorpat, Berlin, Bonn, and Munich. At Würzburg a great building, which had originally served to house a pharmacological institute, was placed entirely at his disposal for the uses of the botanical institute, since become famous throughout the botanical world, and inseparably associated with the name of its founder. Here were assembled rich collections, excellent contrivances for teaching, and instruments without number, all of which bear eloquent testimony to the emphasis which its director laid upon instruction as well as investigation. "Give your chief attention to your lectures," he wrote to me at Bonn in this connection. "Regard the activity of a professor in the way of publication as a thing of much value for its own sake, and the results as things not to be overlooked, yet always bear in mind that the professor is primarily a teacher." In his laboratory Sachs gathered about him a group of young botanists chosen from the whole scientific world, and the "Arbeiten" of the institute became the recognized authority upon physiological research. Baranetsky, Brefeld, F. Darwin, Detlefsen, Dufour, Elfving, Gardiner, Godlewski, Goebel, Hansen, Hauptfleisch, Heinricher, Klebs, Miliarakis, Millardet, Moll, Müller-Thurgau, Nagamatz, Pfeffer, Prantl, Reinke, Scott, Stahl, Frau Professor Tarnowski, Vines, H. de Vries, Marshall Ward, Woronin, Wortmann, Zimmermann, and other botanists of renown, have worked at the institute under Sachs' direction.

Only to those who possessed, like himself, the "heilige Ernst" of their subjects were the privileges of the Institute extended. It was hedged about with such rigid restrictions that those who sought the world-renowned establishment for less commendable purposes were distinctly discouraged. Whoever neglected his work, his apparatus, or his plant-cultures (upon plant-cultures

Sachs laid a special emphasis) even once without valid excuse might be perfectly confident that he would find his place occupied by another. There was always a considerable waiting list for entry into the institute. Sachs took only a limited number (ten) of workers into his laboratory, and for my own first appointment as supernumerary in the famous establishment, I have wholly to thank a warm recommendation from Herr Kölliker.

In the first year of his residence in Würzburg, 1868, there appeared the first edition of the well-known *Lehrbuch*, upon which Sachs had begun definite work almost immediately after the appearance of the *Handbuch*, and which was the fruit of years of previous labor in Poppelsdorf and Freiburg. The same evidences of superiority which had already characterized the *Handbook* appeared in yet higher degree in the later volume. Its presentation and general grasp, as well as the vast amount of preliminary research which the work of the author represented, gave the new work a rank which heretofore had never been attained by any text-book of botany. It was a masterpiece of presentation in text and illustration alike, and not only set forth in clear and critical fashion the facts of plant-life which came within its scope, but presented to a considerable extent theories, unworked problems, and the prophecy of future fields which made it invaluable to botanical research. Even more than the presentation and material of the text, the admirable illustrations gave to the work an excellence not yet surpassed. Today we still meet in nearly all botanical texts these excellent old familiar figures of Sachs. Only two years after the appearance of the first edition of the *Lehrbuch*, a second became necessary, and two years later a third, and in 1874 the fourth appeared. In its translated form this book extended the most recent botanical knowledge and the thought of the modern scientific world into all the lands of culture, and it served the interests of physiological investigation and stimulated general botanical interest in a way which heretofore had been denied any botanical work. According to the testimony of my Ameri-



can friends and colleagues, the *Lehrbuch* has worked wonders in the United States.<sup>4</sup>

It is characteristic of the painstaking and thorough nature of his work that Sachs could never bring himself to permit the appearance of a fifth edition of a book which had been so rapidly prepared. "It had become no longer the expression of my ideas," he writes in the preface to his *Lectures upon Plant Physiology*, in referring to the *Lehrbuch*. The *Lehrbuch*, however, had become the court of last appeal in matters of botanical discussion in its particular field, having been more quoted as an authority than any other botanical work.

To the ripened mind of Sachs there had come to be no longer any pleasure in the mere assembling of facts and critical references, which had been necessary in the preparation of the *Lehrbuch*. His artistic nature had prompted the thought that he had a greater work to do in the way of cultivating that feeling toward nature which is so conspicuously lacking in the majority, and which he regarded as essential. With this thought, he devoted himself to the development of a work which was to contain the whole of his botanical grasp and conviction. This was the origin of his *Vorlesungen*, which yet remains the foundation of all investigation in plant physiology. Perfect in its pleasant and vigorous style of presentation, possessing the charm of keen and comprehensive observation, this remarkable work added to these qualities evidences of a master's ideas of artistic work.

A man of a definite and decidedly original conception of things in general, Sachs was able none the less to regard fairly all subjects from other standpoints than his own, a quality which brought him into thorough sympathy with many other fields of work. In one of his lectures he said: "You shall know the process of reasoning whereby your lecturer has formed the mental picture of the field of science which is his personal belief. Your acceptance of it, however, is quite another thing, and

<sup>4</sup>See Professor Arthur's address before the American Association for the Advancement of Science, 1895. Proc. A. A. A. S., 7, 9, 15, 17, 18. 1895.

whether I am more nearly right than others is a matter which does not enter into the present discussion." The intended function of the *Vorlesungen* was the clear display of a comprehensive picture, confused as little as possible by the universally known facts of plant physiology, and "without the toilsome ballast of apparatus-description, which should be contained in any handbook or text-book published for the profession." Even in the preface to the *Lectures* there is betrayed to the thoughtful observer and psychologist that fine artistic gift possessed by one who was also the keenest and most analytic of investigators.

Whoever has had the good fortune to have been intimately associated with Sachs must have noticed the artistic side of his nature. As a boy he was thoroughly instructed by his father in sketching and in painting. A little later, as the student of the younger Purkinje, a highly gifted painter, he became farther imbued with artistic ideas, and as a student at Prague we find him not only upon the benches of the "Hörsäle," but even zealously engaged in the studio work of the Painters' School. Whoever has seen the large and handsome wall-charts which Sachs used in illustration of his lectures, and which he himself prepared, and has watched the rapid and energetic brush work of a hand as fleet as it was sure, must grant that this genial investigator had the ability of a great artist, and might have achieved fame in the world of art.<sup>5</sup>

How very deeply his artistic nature imprinted itself upon his investigations, and influenced his presentation, is expressed in some words which I have found among his unpublished papers:

With me it has seemed of great importance, and, indeed, has always been a leading thought running through my scientific work, that I should make science as much as possible a work of art, and endeavor in all my publications to use artistic standards in the presentation of the truths of nature. There have been for me, since I began to think independently, no boundary lines between art and nature, and through the course of years I am coming more and more to regard this unity the single goal of my thought. For this

<sup>5</sup>I recall very clearly how once he had painted a green plant entirely red, and answered my astonished inquiry with the words: "Do you mean that you are unable to detect the red which is in the leaf-green?"

reason every kind of controversy has become distasteful to me, for it gains nothing for progress.

With the idea that it should not be a continuation of the *Lehrbuch*, which had already served but to give a practical insight into the subjects discussed, work on the *Vorlesungen* went on until it had attained a bulk almost too great. Sachs' practical appreciation of the difficulties of his students, and his thoughtfulness for them impelled him to publish with Prantl an abridged edition of the *Lehrbuch*, but later Goebel published the systematic part of the earlier *Lehrbuch* as supplementary to the *Vorlesungen*.

As the result of historical investigation, a critical work far different from that which occupied his chief attention, appeared in 1875, the *History of Botany* from the sixteenth century up to 1860. This work formed the fifteenth volume of an historical series published by the Royal Academy of Sciences of Munich, under the patronage of Maximilian II. Sachs' contribution was a departure from any method which had heretofore been employed in the presentation of the history of botany. His material was not arranged according to authors, nor was it presented chronologically. In this history there again appears evidence of that spirit which never let him feel satisfied until he had made out the entire significance of his facts, their mutual interdependence, and the influences which acted upon the development of botanical study. With his clear presentation of confusing facts, he also furnishes to the reader his own well-founded judgment upon the relative value of different periods. In the preface he wrote:

I have conceived as my chief task to discover the first awakening of scientific thought, and to follow its later development through comprehensive theories; this is my estimate of the true history of a science. . . . I have placed here in the foreground as the real makers of our history those men who not only established new facts, but contributed fruitful thoughts as well.

In our judgment, the work of Sachs has been powerful in the construction of what we have called "building material," and he is in the first rank of "geistige" creators. We see him in the last years of his life keen as ever in his scientific contributions,

which appeared in the *Works of the Botanical Institute of Würzburg*; and all the time he was successfully engaged in many fields of work, much devoted to the development of new methods and to the contrivance of apparatus, always adding new "Bausteine," that here the edifice of botanical knowledge might be brought to a harmonious completion, and there new foundations might be laid for later superstructure.

And yet, as though in early youth life's bitterest portions had not already been his, he must even in his declining days keep up a hard and bitter struggle for existence. Body and soul, he was during the whole of his life ardently devoted to his work. From four or five o'clock in the morning until late into the night he was at his researches. In his zealous devotion to his work and to his family he blinded himself to the fatal results of the use of the drug to which he had frequent recourse for stimulation. Yet, what Goethe said of his own life, Sachs could say of his, and in full truth, "It was the constant turning of a stone which ever presented itself anew. The annals of my life are ended when that is said. I have too much credit for my activity. It was correlated with my existence."

Sachs was not only a botanist, he was a philosopher in the best sense. His keen and just regard for his own science was lessened no whit by his relation to art and politics and history. The world had for him the same charms and beauties it had for Goethe. Let these words of Goethe be my final tribute to him who was my master and my friend, to whose fatherly regard the warmest feelings of my heart respond:

*If he was one who stood apart from the world, let it be called well, for the world can be served best by those who are not of it.*

BONN, GERMANY.